



Model Course Outline

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The following is a course proposal for a 75 to 100 hour introductory geospatial technology skills course. The content of the course outline is based upon the Geospatial Technology Competency Model (GTCM) and outcomes from model course outline workshops conducted during summer 2011.

Proposed Course Title: Introduction to Geospatial Technology

Proposed Course Description: Introduction to the fundamentals of Geospatial Technology, including Geographic Information Systems (GIS), Global Positioning Systems (GPS), cartography, remote sensing, and spatial analysis through a series of hands-on computer-based exercises. Participants will learn how to utilize geospatial technology to address social and environmental issues. This course is designed to be used as a stand-alone course to complement other disciplines or as an entry level course into a geospatial program. Course content is based upon the United States Department of Labor's Geospatial Technology Competency Model for entry level geospatial occupations including Geospatial or GIS Technicians and Technologists.

Pre-requisites: Basic computer literacy required; college algebra recommended

Computer Requirement: Access to industry standard geospatial software and a computer with an Internet connection.

Proposed Student Learning Outcomes (SLOs):

1. The student will describe the fundamental concepts of Geographic Information Science and Technology.
2. The student will demonstrate proficiency in the basic functions of geospatial software and hardware.
3. The student will demonstrate basic proficiency in fundamental remote sensing and spatial analysis techniques.
4. The student will demonstrate basic proficiency in map creation and design principles, including thematic map display, employment of map projections and cartographic design.
5. The student will demonstrate proficiency in the creation and acquisition of spatial data including the use of the Global Position System.
6. The student will demonstrate how to access different sources of data, demonstrate the process of creating data, and discuss the fundamental concepts of data quality.



Proposed Course Objectives

All objectives from the GTCM Course Content Survey are listed in the outline below. For this course, each objective is listed as *IN*, *OUT* or *AS TIME PERMITS* as determined by members of the Intro to Geospatial Technology curriculum committee. The *Score* column indicates the rounded averaged ratings of all committee members based upon the following scale:

- 0 = Not important for this course, do not include in this course
- 1 = Slightly important for this course, include only if time permits
Representative Activities: discussed as part of a lecture or reading assignment;
less than 1 class
- 2 = Important for this course, include at an awareness level
Representative Activities: Dedicated lecture and/or writing assignment; test
questions; 1 or more classes
- 3 = Very Important for this course, include at some level above awareness
Representative Activities: Scripted practical project; test working problems or essay;
1 week or more
- 4 = Critically important for this course, must be included in depth
Representative Activities: Open-ended project or integration into larger project;
research paper or defense; 2 weeks or more

An objective designated with an asterisk (*) indicates a foundational objective that is not to be explicitly taught. An objective designated with a plus (+) indicates an objective to be included if the course contains 100 contact hours or more.

All objectives in the outline are grouped into one of ten component categories identified by industry as essential components of the occupation of Geospatial Technician.

- I. Manage Data
- II. Generate Data
- III. Process Data
- IV. Analyze Data
- V. Manage Software
- VI. Manage Projects
- VII. Generate Products
- VIII. Professional Development
- IX. Programming
- X. Other



Proposed Course Outline:

I. Manage Data

The committee recommended that the class include the following core course objectives:

Score	Objective (IN)
4	Describe the characteristics and appropriate uses of common coordinate systems, projections, datums and geoids
4	Acquire data
3	Apply appropriate data formats (Vector, Raster, TINs, Imagery)
3	Explain the relationship of horizontal datums to coordinate system grids and geometric approximations of Earth's shape
3	Acquire and integrate a variety of field data, image data, vector data, and attribute data to create, update, and maintain GIS databases
3	Perform spatial and non-spatial data joins and link, join and relate tables
3	Critique the design of a given map in light of its intended audience and purpose
3	Explain how map scale affects data collection and management
3	Describe different data formats (Vector, Raster, TIN, etc.)
3	Research and evaluate data sources
3	Define feature behaviors and relationships
3	Evaluate how to verify spatial data accuracy, quality, compatibility and appropriateness for application
3	Define data requirements (format, projections, etc.)
3	Create and maintain data dictionary
3	Define database fields
3	Design Database Structure (e.g. schema)
3	Develop (construct) databases (e.g. define geometry & attributes)

The committee recommended including the following course objectives if class time permits:

Score	Objective (If Time Permits)
1	Create and build topology
1	Optimize database structure
1	Optimize data file folders (Adv.)
1	Conduct database performance tuning (e.g. compress, build stats, index) (C)

The following objectives were not included due to one or more of the following reasons: 1) There was redundancy with other objective(s) either in this section or another section; 2) The objective was not applicable, beyond the scope, or too advanced for an introductory course:



Score	Objective (OUT)
0	Develop data maintenance schedule
0	Establish data custodianships and permissions

II. Generate Data

The committee recommended that the class include the following core course objectives:

Score	Objective (IN)
4	Apply appropriate map scale when creating or acquiring data
3	Input Data
3	Digitize data (tablet or heads up)
3	Geocode data
3	Collect field data electronically
3	Describe the GNSS system and important concepts and uses
2	Assess current technologies used in data collection.
2	Collect field data using GPS (location and attribute)
2	Collect field data manually
2	Perform data format conversions (vector to raster, raster to vector)

The committee recommended including the following course objectives if class time permits:

Score	Objective (If Time Permits)
1	Describe the basic concepts and techniques that are used in surveying to collect and store data
1	Scan non-digital data
1	Explain the distinction between GNSS data post-processing and real time processing
1	Explain how to use and coordinate geodetic control prior to mapping
1	Create TINs from feature data
1	Explain GNSS data quality issues, such as multipath, PDOP, and signal-to-noise ratio
1	Explain major GNSS error sources, such as ionospheric delay, clock error, ephemerides, and satellite health
1	COGO legal descriptions (digitize using COGO e.g. meets & bounds)

The following objectives were not included due to one or more of the following reasons: 1) There was redundancy with other objective(s) either in this section or another section; 2) The objective was not applicable, beyond the scope, or too advanced for an introductory course:

Score	Objective (OUT)
0	Explain the distinction between a property boundary and its representations, such as



	deed lines, lines on imagery, boundary depictions in cadastral databases
0	Illustrate the differences between ellipsoidal (or geodetic) heights, geoidal heights, and orthometric elevation in relation to GNSS
0	Produce an orthoimage data product with geometric accuracy suitable for project requirements
0	Post process GPS Data
0	Plot a legal boundary description from a deed or plat
0	Plan a GNSS data acquisition mission that optimizes efficiency and data quality
0	Perform requirements analysis for remotely sensed data acquisition using resolution concepts
0	Explain the concept of "bit depth" and its implications for remotely-sensed image data
0	Explain how spatial autocorrelation influences sampling strategies and statistics
0	Identify and describe characteristics of inertial measurement systems and other geospatial measurement systems
0	Collect and integrate carrier phase (survey grade) GNSS positions and associated attribute data with other geospatial data sets
0	Plan a remotely sensed data acquisition mission, including specifying an appropriate sensor and platform combination suited for particular project requirements
0	Make and justify a choice between Real time Standard Positioning Service (SPS) and Real time Precise Positioning Service (PPS) for a given objective
0	Design a questionnaire and interview protocol for acquiring georeferenced socio-economic data
0	Describe the components and operation of an aerotriangulation system
0	Diagram the sequence of functions involved in producing georeferenced textual information harvested from social media sites and the World Wide Web
0	Compare how land records are administrated in the U.S. in comparison with other developed and developing countries
0	Design an integrated measurement system solution for acquiring and processing geospatial data

III. Process Data

The committee recommended that the class include the following core course objectives:

Score	Objective (IN)
4	Organize file structure (e.g. create directories, perform data & directory housekeeping)
4	Create directory structure
4	Create naming conventions
4	Organize digital and non-digital data (e.g. data library)
4	Describe different methods of indicating locations (e.g., decimal degrees, UTM)



4	Apply appropriate projections
4	*Demonstrate how to Import/Export data from various sources (e.g. spreadsheets)
3	Demonstrate how to Archive and Backup Data
3	Edit and update attribute and spatial data
3	Update spatial and non-spatial data attributes
3	Define data's spatial reference
3	Demonstrate how to create/update data
3	Determine data needs and format
3	Georeference data
3	Create/update metadata
3	Edit feature geometry
3	Convert data between formats (e.g. KML, XML, RSS) (Adv.)
3	Define data collection methods (e.g. GPS, air photo)
3	Obtain imagery, basemap and terrain feature data
3	Normalize data structure (e.g. schema)
3	Organize written information (i.e., reports, resumes).
2	Demonstrate how to connect to external data sources (e.g. odbc, GIS servers)
2	Describe how to export data in transferable format
2	Describe Quality Assurance / Quality Control for acquiring and maintain data
2	Adhere to policies for sharing and receiving data
2	Rectify raster data (e.g. rubbersheeting)
2	Verify content and spatial accuracies of data
2	Transform spatial data (e.g. reprojections)
2	Post / reconcile edits (e.g. changes)

The committee recommended including the following course objectives if class time permits:

Score	Objective (If Time Permits)
1	Validate spatial and tabular data (e.g. topology, build, verification)
1	Conduct Ground Truthing
1	Explain conversion of digital formats - data abstraction (cut, simplify, stretch & fit)

There were no objectives considered "Out" for the Process Data component.

IV. Analyze Data

The committee recommended that the class include the following core course objectives:

Score	Objective (IN)
4	Perform Queries



3	Perform buffer analysis
3	Conduct Geoprocessing (e.g. clip, buffering, overlay, run models, map algebra)
3	Perform overlay analysis.
3	Perform proximity analysis
3	Interpret Results from analysis (is it appropriate/good)
3	Describe basic concepts and use of remote sensing images
2	Observe and report data anomalies
2	Interpret topography (i.e., contour lines).
2	Pre-process Data (e.g. generalize, subset)

The committee recommended including the following course objectives if class time permits:

Score	Objective (If Time Permits)
1	Perform site selection
1	Perform statistical analysis
1	Perform view shed analysis
1	Perform Basic Analytical Methods (point pattern analysis, cluster analysis, multi-criteria evaluation, and spatial process models)
1	Derive new data (e.g. generate contours from DEM, data generalization)
1	Identify shortest/optimal route that accounts for visibility, slope, and specified land uses
1	Determine appropriate image data and image analysis techniques needed to fulfill project requirements
1	Describe basic concepts and use of photogrammetry
1	Conduct image analysis (e.g. classification)
1	Develop orthophotography
1	Interpret Imagery
1	Create Models (e.g. process & scientific models, flow charts)
1	Explain the difference between pixel-based and object-based image classification
1	Conduct slope analysis
1	Identify least-cost path
1	Conduct network analysis
1	Classify remote sensing data (reclassify, supervised, unsupervised)
1	Create composite images (true, false, NDVI)

The following objectives were not included due to one or more of the following reasons: 1) There was redundancy with other objective(s) either in this section or another section; 2) The objective was not applicable, beyond the scope, or too advanced for an introductory course:

Score	Objective (OUT)
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0	Use sampling techniques (eg. random, stratified, etc.)
0	Explain how leading online routing systems work, and account for common geocoding errors
0	Employ cartographic techniques to represent different kinds of uncertainty, including uncertain boundary locations, transitional boundaries, and ambiguity of attributes
0	Geostatistics, including spatial sampling, semi-variogram modeling, and kriging
0	Evaluate the thematic accuracy of a data product derived from aerial image interpretation, such as a soils map, using ground verification methods
0	Conduct geostatistical analysis
0	Apply principles of computational geometry.
0	Data Mining, including pattern recognition
0	Explain how to quantify the thematic accuracy of a land use/land cover map derived from remotely-sensed imagery
0	Use location-allocation software functions to locate service facilities that satisfy given constraints
0	Perform object-oriented image classification using specialized software tools
0	Model linear networks
0	Outline workflows that identify sequence of procedures involved in geometric correction, radiometric correction, and mosaicking of remotely sensed data
0	Assess the current state of the art in coupling predictive models and simulations with GIS software
0	Perform network analysis (dynamic segmentation)
0	Conduct segmentation with linear reference data
0	Define the sampling theorem in relation to the concept of spatial resolution of remotely-sensed imagery
0	Establish, re-establish and/or monument property boundaries; represent such boundaries in plats, records, and descriptions, all under personal and professional liability as stipulated in legal statute and precedent
0	Explain the Modifiable Areal Unit Problem in relation to the "ecological fallacy"
0	Compare characteristics and appropriate uses of geospatial modeling techniques, such as neural networks, cellular automata, heuristics, agent-based models, and simulation models such as Monte Carlo simulation

V. Manage Software

The committee recommended that the class include the following core course objective:

Score	Objective (IN)
1	+Determine hardware /software requirements/ constraints

The committee recommended including the following course objectives if class time permits:



Score	Objective (If Time Permits)
1	Apply basic programming Principles (SQL statements, Boolean logic, macros)
1	Describe how a user should maintain software
1	Install Software (e.g. enhancements, service packs) (C)
1	Comply with software licensing agreements
1	Describe how to Install software upgrades
1	Automate repetitive tasks

The following objectives were not included due to one or more of the following reasons: 1) There was redundancy with other objective(s) either in this section or another section; 2) The objective was not applicable, beyond the scope, or too advanced for an introductory course:

Score	Objective (OUT)
0	Conform to policy and standards
0	Modify basic scripts
0	Make project recommendations
0	Test application performance
0	Automate Manual Processes
0	Use appropriate programming languages (e.g.,SQL, VB, HTML, Python, etc.)
0	Create scripts
0	Select database software (performance, usability, cost, manageability, uses, output format)
0	QA/QC software applications (e.g. beta test)
0	Provide Technology Recommendations
0	Determine programming tools required to develop applications
0	Recommend software upgrades
0	Enhance existing custom applications
0	Develop software applications
0	Develop application to simplify and/or standardize procedures
0	Determine application design format (e.g. platform, language)
0	Recommend new technologies
0	Produce application recommendation files
0	Exercise quality control (Application Dev't)
0	Maintain workstation security

VI. Manage Projects

The committee recommended that the class include the following core course objectives:



Score	Objective (IN)
3	Identify the Problem
3	Describe different applications and uses of geospatial technology
3	Apply critical thinking and problem solving skills when developing a project
3	Choose and Implement a Solution
3	Apply principles of geography to projects
3	Formulate problem, collect data through observation and the formulation and testing of a hypothesis
2	Develop/document procedures and guidelines
2	Monitor project progress and verify that project goals are met
2	Document Project results
2	Develop Project Plan
2	+Determine project timeline (schedule, priorities, workload)
2	+Define project scope
2	+Determine resource requirements
2	+Determine project needs (e.g., client needs)
1	+Act in the best interests of the company, your co-workers and your community.

The committee recommended including the following course objectives if class time permits:

Score	Objective (If Time Permits)
1	Generate Alternatives
1	Describe how to coordinate project activities
1	Describe some common industry standards for geospatial technology (e.g. ISO 9000, metadata, etc.)
1	Describe how copyright laws may apply to data and projects
1	Establish project standards
1	Conform to policy and standards

The following objectives were not included due to one or more of the following reasons: 1) There was redundancy with other objective(s) either in this section or another section; 2) The objective was not applicable, beyond the scope, or too advanced for an introductory course:

Score	Objective (OUT)
0	Explain how to coordinate with a Project Team, stakeholders, consultants and IT
0	Prepare budget and cost estimates (e.g., time, equipment, data acquisition)
0	Describe how to maintain contracts

VII. Generate Products



The committee recommended that the class include the following core course objectives:

Score	Objective (IN)
4	Create maps using cartographic principles
4	Determine appropriate map scale
4	Recognize and apply cartographic conventions
4	Design map layouts
4	Describe different types of maps (e.g., road, terrain, choropleth)
4	Describe purpose and use of maps
4	Determine appropriate scale and projection
3	Describe and apply appropriate symbology, fonts and colors
3	Design Cartographic Elements
3	Create thematic maps (e.g. zoning)
3	*Present project summary
3	*Provide information presentations
3	*Present ideas clearly and concisely.
3	Create Database Tables
3	Create charts, graphs, tables
3	*Communicate with peers, clients, co-workers
3	Create reference maps (e.g. streets)
3	Demonstrate knowledge of map Interpretation.
3	Adhere to purpose and use of maps
3	Perform Graphic Design
3	Select proper media/output device
3	Acknowledge contributors and copyrights
3	Create state and interactive maps
3	Create map templates
3	Create graphic items (e.g. logos, headers, posters, exhibits) (E,C)
3	Create reports on analysis, project status, outcomes, etc.
3	Define project Deliverables
2	Resolve spatial conflicts.
2	Load/Burn Data onto Media
2	Publish Map Products
1	+Create and present geospatial projects

The committee recommended including the following course objectives if class time permits:

Score	Objective (If Time Permits)
1	Disseminate documentation where appropriate
1	Calculate scale transformations.



1	Communicate quality control problems to other team members.
1	Disseminate information through a web site
1	Publish spatial information on-line
1	Distribute data according to organizational policy (E,C)
1	Inform data users and custodians of update completion

The following objectives were not included due to one or more of the following reasons: 1) There was redundancy with other objective(s) either in this section or another section; 2) The objective was not applicable, beyond the scope, or too advanced for an introductory course:

Score	Objective (OUT)
0	Create animations (e.g. 3D, 4D)
0	Manage Web Content

VIII. Professional Development

The committee recommended that the class include the following core course objectives:

Score	Objective (IN)
3	Research GIS Technology Trends
2	Identify allied fields that rely on geospatial technology and that employ geospatial professionals
2	Identify legal, ethical, and business considerations of geospatial data
2	+View job related information (e.g. blogs, news feeds, print publications, forums)

The committee recommended including the following course objectives if class time permits:

Score	Objecting (If Time Permits)
1	Review industry publications
1	Describe how a code of ethics may be part of a geospatial profession
1	Network with industry professionals
1	Promote/Represent GIS
1	Participate in professional organizations, workshops and conferences
1	Explore new geoprocessing techniques
1	Attend Training
1	Describe possible types of certification available to geospatial occupations
1	Describe possible types of training events available to workforce
1	Create "read me" files



The following objectives were not included due to one or more of the following reasons: 1) There was redundancy with other objective(s) either in this section or another section; 2) The objective was not applicable, beyond the scope, or too advanced for an introductory course:

Score	Objective (OUT)
0	Visit trade shows
0	Develop users guides
0	Demonstrate how to build help files
0	Troubleshoot hardware/software problems
0	Write Technical Guides
0	Resolve user technical problems

IX. Programming

The committee recommended that the class include the following core course objectives:

Score	Objective (IN)
2	Compare the capabilities and limitations of different types of geospatial software, such as CAD, GIS, image processing
2	Employ query languages such as SQL to interrogate spatial databases

The committee recommended including the following course objectives if class time permits:

Score	Objective (If Time Permits)
1	Identify the components of a GIS
1	Utilize new architectural opportunities such as cloud computing
1	Compare benefits and shortcomings of desktop, server, enterprise, and hosted (cloud) software applications
1	Evaluate open source software components for re-use and potential return contributions

The following objectives were not included due to one or more of the following reasons: 1) There was redundancy with other objective(s) either in this section or another section; 2) The objective was not applicable, beyond the scope, or too advanced for an introductory course:

Score	Objective (OUT)
0	Recognize GIS tasks that are amenable to automation, such as route generation, incident response, and land use change analysis
0	Recognize opportunities to leverage positioning technology to create mobile end-user applications
0	Work effectively in teams to plan and coordinate software and application



	development
0	Communicate effectively with end-users to ensure that software applications meet user needs
0	Demonstrate understanding of common geospatial algorithms, such as geocoding or drive time analysis, by writing or interpreting pseudo code
0	Perform a feasibility study and cost/benefit analysis
0	Identify the factors that affect the interoperability of geospatial software applications
0	Use scripting languages such as JavaScript, PHP, and KML to create web mapping applications
0	Identify alternatives for customization and automation, such as APIs, SDKs, scripting languages
0	Identify appropriate software development tools for particular end uses
0	Develop use cases for user-centered requirements analyses
0	Customize geospatial software using proprietary and open source software components, such as ESRI's ArcObjects, Intergraph's GeoMedia software suite, and the GeoTools open source project
0	Design a geospatial system architecture that responds to user needs, including desktop, server, and mobile applications
0	Realize opportunities to leverage positioning technology to create mobile end-user applications
0	Explain how geospatial software in large enterprises fits into SOA (ServiceOriented Architectures) and SaaS (Software as a Service)
0	Ensure that software code complies with industry standards, such as those promulgated by the Open Geospatial Consortium (OGC)
0	Optimize geospatial system performance
0	Create geospatial software programs using programming languages such as C, C++, and Java

X. Other

The committee recommended that the class include the following core course objectives:

Score	Objective
3	Demonstrate understanding of the conceptual foundations on which geographic information systems (GIS) are based
3	Identify spatial patterns; apply knowledge of how people and places are linked
3	Demonstrate a working knowledge of GIS hardware and software capabilities, including GPS/GIS mapping systems
3	Utilize internet and email applications
3	*Number Operations and Computation - addition, subtraction, multiplication, and division
3	*Number Systems and Relationships - whole numbers, decimals, fractions, and



	percentages
3	Utilize online help and other technical resources
3	*Measurement and Estimation - measurement of time, temperature, distances, length, width, height, perimeter, area, volume, weight, velocity, and speed; unit conversion; numerical analysis to obtain approximate solutions when necessary
3	Apply geographic information relating to the Human–Environment Interaction, Regional Geography, Physical Geography, Cultural Geography
2	*Geometry - size, shape, and position of features using geometric principles to solve problems
2	*Mathematical Reasoning and Problem Solving - inductive and deductive reasoning, conjectures, arguments, strategies, and interpretation of results

The committee recommended including the following course objectives if class time permits:

Score	Objective (If Time Permits)
1	Specify uses of standard non-spatial data models, specifically the relational data model and its extensions
1	Use Writing and Publishing Applications
1	Algebra - equations, patterns, functions, 3D vectors, and matrices
1	Trigonometry - relationships among the sides and angles of triangles on planes and spheres

The following objectives were not included due to one or more of the following reasons: 1) There was redundancy with other objective(s) either in this section or another section; 2) The objective was not applicable, beyond the scope, or too advanced for an introductory course:

Score	Objective (OUT)
0	Mathematical Notation - the language of mathematics to express mathematical ideas
0	Engineering Methods: Design technical plans, blueprints, drawings, and models.